tions for putting the models together, which consist of flat cardboard marked in accordance with the printed descriptions. The whole is contained in a neat quasi-envelope (nine inches by seven).

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

Glass for Reflectors

YOUR last number (vol. xvii. p. 226) contains a very interesting paper by Mr. Norman Lockyer, in which that gentleman quotes the following passages from Mr. Grubb's paper :—

"For the 4-foot disc of glass for the Paris reflector, in place of that which has so recently resulted in failure, the St. Gobain Glass Company require twelve months' time to perfect (although, be it remembered, the quality of the glass is here of no consequence whatever) ; and I have been myself in correspondence with the principal glass manufacturers here and on the Continent, and not one of them is willing to undertake even a 6-foot glass disc ; so that it would appear that, above that size, the silver-on-glass mirrors are out of the question." . . . . "The other great difficulty in the manufacture of reflectors is the annealing of the disc, and I believe it is this difficulty which limits to so narrow an extent the production of glass discs for silver-on-glass mirrors."

It may be interesting to your readers to know that an attempt is now being made to entirely overcome the apparently insurmountable difficulties so clearly pointed out by Mr. Grubb, and to obtain at any time without delay, and at a very small cost, discs of glass suitable for making silvered reflectors from 6 to 8, or even 10 feet in diameter.

It is almost impossible to over-rate the difficulty of producing massive discs of glass such as the one employed for the 47¼-inch reflector of the Paris Observatory, weighing, as it did, no less less than 1,546 lbs. in the rough, for, however carefully annealed such a mass of brittle, slow-conducting material may be, it will always be liable to unequal expansion, deflection, and fracture.

Fortunately, however, we have commercial plate glass to fall back upon ; plates of 1 to 1½ inch in thickness can be readily made and perfectly annealed, and it is to the substitution of these large and comparatively thin sheets of glass, in lieu of thick cast masses, that my attention has been chiefly directed.

It is perfectly well known that plates of 1 to 1½ inches in thickness, if of large area, are subject to a great amount of deflection and consequent distortion of the image, which no ordinary support or backing can prevent. Several modes of converting such thin discs of commercial plate glass into efficient reflectors are about to be put to the test of practical experiment for the 50¼-inch silver-on-glass reflecting telescope which I am making and erecting at my residence on Denmark Hill.

Any attempt to support a disc of this diameter of 1½ inch in thickness against a cucheon of any kind, or loosely against a plane, must end in failure ; nor can we hope to escape the difficulty by cementing the glass to any foreign substance whose power of conducting heat and rate of expansion differs from that of glass, as a giving way of the cement would be only a question of time, while distortion would result from unequal expansion of the two different materials. An intermediate course has therefore been adopted.

A strongly ribbed hollow cellular casting is made of iron 52½ inches in diameter, and 13 inches in thickness, weighing 1,400 lbs. ; after slowly cooling in its mould, it will be again heated to about 900° F., and then be again slowly cooled ; the whole of the external skin of the casting will be turned off in the lathe, and its face made into a true plane, less the final process of scraping ; it will then be thrice annealed in oil, each time slowly raising the temperature from 60° up to 600° F., and each time slowly cooling it again. When all undue tension has thus been got rid of, its face will be finally scraped to a true plane, and a small spiral channel $\frac{1}{16}$ of an inch deep, and the same in width, will be formed on the flat face, the channels being about ½ an inch apart from each other, and extending from the centre nearly to the outer edge of the metal surface. One side of the glass disc having been previously ground flat by the plate-glass manufacturer, will have a second grinding on the grooved plane, so as to insure perfect contact all over its surface ; the emery having been all carefully removed, the surface of the iron plane is to be slightly moistened with olive oil, and the disc of glass replaced upon it. A flanged iron ring will then be placed around the glass disc, and screwed firmly to the iron surface, leaving a clear annular space of about ⅜ of an inch wide between the periphery of the glass disc and the ring ; a permanently tenacious viscous matter (of the character of soft marine glue) will then be poured into this annular space, forming an air-tight junction between the iron plate and the glass surface, and at the same time admitting the glass to expand or contract freely. A partial vacuum will then be formed beneath the glass by exhausting the air through a central hole communicating with the spiral groove ; the glass disc will then be held firmly in contact with the entire surface of the iron plane, which, however, is free to slide under the glass when undergoing expansion or contraction. I have found by repeated experiments (many years ago) that plate glass (say of ¼ of an inch only in thickness) so held on to an unyielding plane, may be repeatedly struck by the rounded face of a heavy wooden mallet, with the greatest violence, without producing a single fracture, so complete is the support thus afforded.

It is important to bear in mind that a glass disc so held does not rest on its lower edge when placed in a vertical position, nor are the upper portions of the plate allowed to press on, and be supported by the lower ones, as is inevitably the case with a mirror loosely suspended in a sling in the ordinary manner, but on the contrary, every portion of the glass disc is sustained and supported in position by atmospheric pressure, and held flatly and firmly against a corresponding portion of the unyielding iron plane, free from any accumulated downword pressure.

The expansion by heat of plate-glass and cast-iron are in round numbers as 19 is to 22, and the differential amount of this expansion between the extreme range of summer and winter temperatures, would cause the iron to exceed the diameter of the glass by about $\frac{1}{400}$ of an inch ;—this minute sliding motion of the two smooth planes upon each other would not in the slightest degree alter the curved face of the mirror.

The glass disc having been thus finally and permanently attached to the iron plane, the latter would be supported in its cell by bands passing round it as usual, and with a system of triangular supports at the back. The weight of this strong-ribbed hollow cellular plane, of 13 inches in thickness, is only 1,400 lbs., while a disc of equal diameter in speculum metal, if only 4½ inches in thickness, would weigh about 2,700 lbs. ; hence such a compound metal and glass reflector is lighter than a solid cast glass one, and but little more than one-half the weight of a reflector made of ordinary speculum metal, while its thickness being three times as great as the latter, it would, when in use, and also while undergoing the polishing operations, be perfectly free from deflection.

Hitherto I have spoken only of the mode of mounting the glass disc on its iron support ; it now remains to convert the flat surface of the glass disc into a shallow concave reflector. For this purpose I have made experiments in turning glass concaves with a diamond-cutting tool mounted on a slide-rest, and I have found that in this way glass affords nearly the same facilities for shaping in the lathe that iron or brass would do under similar conditions ; it therefore follows that lenses of all shapes and sizes may be brought approximately to a true figure with very great ease and rapidity.

Satisfied with this result, I am now erecting in my laboratory a lathe of peculiar construction and specially adapted to this purpose with a bed fifty feet in length, and having a fifty-four inch diameter face plate at each end of the mandril. A massive radius-bar or frame of double the intended focal length of the reflector, moves on an adjustible pivot attached to the lathe-bed, while the other end of the radius frame carries a slide-rest in which a diamond-cutting tool is mounted, and by means of which a spherical concavity is rapidly and truly turned over the whole face of the glass disc, and of any desired radius, while a second plate of glass or metal is turned into a convex surface on the other face-plate of the lathe, thus furnishing a convex grinder of the exact same radius as the concave reflector. Special arrangements are made to neutralise any difference in the length of the radius-frame by expansion or contraction during the turning operation, and provision is also made for gauging to the

$\frac{1}{100}$th of an inch the focal length of the convex and concave surfaces under operation.

Although I have heretofore described the cellular casting as having a flat face, it will be obvious that if made into a concave corresponding with the intended focal length of the reflector that much thinner sheets of glass than those before named may be employed by first bending them to the required curve and fitting them by grinding to the concave iron surface, so that a glass reflector can on this principle be made just as large as a plate-glass manufacturer can produce an ordinary thin plate.

A description of the novel arrangements which I employ for grinding and polishing the spherical concave reflector, and its conversion into a paraboloid of revolution would carry me far beyond the already too lengthy remarks I have made, and which had for their primary object simply to show that we may still have good reason to hope that silver-on-glass reflectors of large diameters are within our reach. HENRY BESSEMER

Denmark Hill, January 21

A Telephone Without Magnetism

FOR some time past I have been experimenting with the view of transmitting articulate sounds through wires without the aid of electricity or magnetism.

I have now been quite successful, my experiments proving that the sounds of the human voice can be carried by *vibrations* through considerable lengths of wire.

Last night conversation was carried on with ease between *four* individuals, situated in different rooms. Piano music, singing, laughing, and breathing, were all clearly transmitted to the ear. The whole distance would be about fifty yards.

The communication was effected by means of a mouth-piece with a vibrating disc in connection with the wire.

Glasgow W. J. MILLAR

Change of Habits in Toads

WHILE prosecuting my field-work as Palæontologist of the United States Geological Survey of the Territories, under the direction of Prof. F. V. Hayden, in Colorado, during last season, I had the opportunity to make some very interesting observations in relation to a change of habits in the common toad (*Bufo americana*). The district referred to is that portion of the great plains which lies immediately adjacent to the eastern base of the Rocky Mountains, and which is traversed by the South Platte River and its tributaries there.

The valleys of these streams are broad and shallow, and the streams heading in the immediately adjacent mountains have an abundant flow of water; so that large tracts of land in all those valleys have been brought under cultivation by irrigation. Irrigation is necessary in all that region, for it lies within that portion of the United States domain upon which the annual rainfall is insufficient for the purposes of agriculture.

With the irrigation of the land came increased and perennial vegetation; with that came increased insect-life, and with that an increase of birds and toads. The irrigating ditches are everywhere numerous, and during the season of growing crops they are frequently visited by men to regulate the flow of water to the land.

This and other circumstances disturb the toads that frequent the shades of the herbage which grows upon the borders of the water. It is no uncommon thing for toads as well as frogs, to jump into the water when disturbed, but the habit of the former is to make a shallow dive, rise immediately to the surface, and swim upon it by a sweeping curve to the shore again, not resting until the brink is gained, upon which they tarry a while before coming upon the land.

Frogs, on the contrary, when disturbed, make a strong dive directly to the bottom, upon which they lie prone, with the legs flexed against the body, and into the mud of which they settle themselves a little. Here they remain and exhaust the patience of one who may attempt to wait for them to rise. Now the toads in this irrigated region have adopted precisely these common habits of the frogs when disturbed upon the borders of the ditches, as I repeatedly witnessed. I regard this as the resumption of an instinctive trait that has been potentially transmitted from a former race of Anourans that were less differentiated than frogs and toads are now from each other; and that the lately introduced change of physical conditions in the region has caused the toads to resume habits which the frogs have never abandoned.

Washington, D.C., January 6 C. A. WHITE

Talking Photographs

THE article from the *Scientific American* on the phonograph which is quoted in NATURE, vol. xvii. p. 190, concludes as follows:—"It is already possible, by ingenious optical contrivances, to throw stereoscopic photographs of people on screens in full view of an audience. Add the talking phonograph to counterfeit their voices and it would be difficult to carry the illusion of real presence much further."

Ingenious as this suggested combination is, I believe I am in a position to cap it. By combining the phonograph with the kinesigraph I will undertake not only to produce a talking picture of Mr. Gladstone which, with motionless lips and unchanged expression shall positively recite his latest anti-Turkish speech in his own voice and tone. Not only this, but the life-size photograph itself shall move and gesticulate precisely as he did when making the speech, the words and gestures corresponding as in real life. Surely this is an advance upon the conception of the *Scientific American!*

The mode in which I effect this is described in the accompanying provisional specification, which may be briefly summed up thus: Instantaneous photographs of bodies or groups of bodies in motion are taken at equal short intervals—say quarter or half seconds—the exposure of the plate occupying not more than an eighth of a second. After fixing, the prints from these plates are taken one below another on a long strip or ribbon of paper. The strip is wound from one cylinder to another so as to cause the several photographs to pass before the eye successively at the same intervals of time as those at which they were taken.

Each picture as it passes the eye is instantaneously lighted up by an electric spark. Thus the picture is made to appear stationary while the people or things in it appear to move as in nature. I need not enter more into detail beyond saying that if the intervals between the presentation of the successive pictures are found to be too short the gaps can be filled up by duplicates or triplicates of each succeeding print. This will not perceptibly alter the general effect.

I think it will be admitted that by this means a drama acted by daylight or magnesium light may be recorded and reacted on the screen or sheet of a magic lantern, and with the assistance of the phonograph the dialogues may be repeated in the very voices of the actors.

When this is actually accomplished the photography of colours will alone be wanting to render the representation absolutely complete, and for this we shall not, I trust, have long to wait.

WORDSWORTH DONISTHORPE

Prince's Park, Liverpool, January 12

Sun-spots and Terrestrial Magnetism

I BEG to direct Prof. Piazzi Smyth's attention to an article in the *Annuaire du Bureau des Longitudes* for 1878 by M. Faye, entitled "La Météorologie Cosmique," in which this distinguished astronomer and meteorologist says:—"La période des taches, portée à 11$^{\text{ans}}$·1 par M. Wolf n'étant pas égale à celle des variations magnétiques (10$^{\text{ans}}$·45), ces deux phénomènes n'ont aucun rapport entre eux." It thus appears rather premature to suppose that the sun-spot cycle and the terrestrial magnetic diurnal oscillation cycle are intimately connected. A. W. DOWNING

Greenwich, January 21

Great Waterfalls

IN reply to Mr. Guillemard's inquiry in NATURE (vol. xvii. p. 221) he will find some account of the Kávari or Cauvery Falls in the "Mysore Gazetteer," recently compiled under orders of the Indian Government, vol. ii. pp. 271–273 (Bangalore, 1876). A copy is doubtless to be seen at the India Office Library.

Edinburgh, January 21 W. W. HUNTER

Mechanical Analysis of the Trevelyan Rocker

ALMOST every physical cabinet possesses one of Trevelyan's rockers, and yet it is rare to find one which always works well and gives complete satisfaction. Some two years ago having experienced this difficulty in New York, where I was then Professor of Physics, I requested Mr. Robert Spice, F.C.S., of 230, Bridge Street, Brooklyn, U.S., a very skilful constructor of acoustic instruments, and a thorough physicist, to make for me several of these rockers and ascertain, if possible, the conditions